How many liters of oxygen must combine with 1.8 moles of ethane (C_2H_6) at STP when ethane combusts?

$$2C_2H_6 + 7O_2 \longrightarrow 4CO_2 + 6H_2O$$

A B

$$1.8\,\text{mol A}\left(\frac{7\,\text{mol B}}{2\,\text{mol A}}\right)\left(\frac{22.4\,\text{L}}{1\,\text{mol B}}\right) = 141.12\,\text{L}\,O_2$$

What volume of water vapor is produced at STP when 3 moles of oxygen combine with an excess of hydrogen?

$$2H_2 + O_2 \rightarrow 2H_2O$$

A B

$$3\,\text{mol A}\left(\frac{2\,\text{mol B}}{1\,\text{mol A}}\right)\left(\frac{22.4\,\text{L}}{1\,\text{mol B}}\right) = 134.4\,\text{L}\,H_2O$$

The black oxide of iron, Fe_3O_4, occurs in nature as the mineral magnetite. This substance can also be made in the laboratory by the reaction between red-hot iron and steam according to the following equation. (3 ways to solve for Limiting reactants I'll show 2 here and 1 below.)

$$\underset{A}{3}Fe_{(s)} + \underset{B}{4}H_2O_{(g)} \rightarrow \underset{C}{}Fe_3O_{4(s)} + \underset{}{4}H_{2(g)}$$

a. When 36.0 g of H_2O is mixed with 167 g of Fe, which is the limiting reactant?

Compare mole ratios

From Equation $\frac{3\text{ mol Fe}}{4\text{ mol } H_2O}$

From Given $36\text{g } H_2O = 2\text{ moles } H_2O$ (limiting)

$167\text{g Fe} = 3\text{ moles Fe}$

Determine exactly how much of each reactant is needed.

$$36.0\text{g B}\left(\frac{1\text{mol B}}{18.02\text{g}}\right)\left(\frac{3\text{mol A}}{4\text{mol B}}\right)\left(\frac{55.85\text{g A}}{1\text{mol A}}\right) = 83.7\text{g Fe}$$

b. What mass in grams of black iron oxide is produced? (Always start w/ limiting)

$$36.0\text{g A}\left(\frac{1\text{mol A}}{18.02\text{g A}}\right)\left(\frac{1\text{mol C}}{4\text{mol A}}\right)\left(\frac{231.55\text{g C}}{1\text{mol C}}\right) = 115.7 \rightarrow \boxed{116\text{g } Fe_3O_4}$$

c. What mass in grams of excess reactant remains when the reaction is completed?

See 2nd solution for A

Given — need = Excess (left over)

$167\text{g Fe} - 83.7\text{g Fe} = \boxed{83.3\text{g Fe}}$

Sulfuric acid reacts with aluminum hydroxide by double replacement.

$$\underset{A}{3}H_2SO_4(aq) + \underset{B}{2}Al(OH)_3(aq) \rightarrow \underset{}{6}H_2O(l) + \underset{C}{}Al_2(SO_4)_3(aq)$$

a. If 30.0 g of sulfuric acid react with 25.0 g of aluminum hydroxide, identify the limiting reactant. Solve for product using both reactants. which ever produces the least amount of product is the limiting reactant.

$$30.0\text{g A}\left(\frac{1\text{mol A}}{98.08\text{g}}\right)\left(\frac{1\text{mol C}}{3\text{mol A}}\right)\left(\frac{342.14\text{g C}}{1\text{mol C}}\right) = 34.9\text{g } Al_2(SO_4)_3$$

$$25.0\text{g B}\left(\frac{1\text{mol B}}{78.00\text{g}}\right)\left(\frac{1\text{mol C}}{2\text{mol B}}\right)\left(\frac{342.14\text{g C}}{1\text{mol C}}\right) = 54.8\text{g } Al_2(SO_4)_3$$

H_2SO_4 is limiting

b. Determine the mass of excess reactant remaining.

$$30.0\text{g A}\left(\frac{1\text{mol A}}{98.08\text{g A}}\right)\left(\frac{2\text{mol B}}{3\text{mol A}}\right)\left(\frac{78.00\text{g B}}{1\text{mol B}}\right) = 15.9\text{g } Al(OH)_3 \text{ needed}$$

$25.0\text{g } Al(OH)_3 - 15.9 = \boxed{9.1\text{g}}$ Excess

given — needed

c. Determine the mass aluminum sulfate formed.

$$30.0\text{g A}\left(\frac{1\text{mol A}}{98.08\text{g A}}\right)\left(\frac{1\text{mol C}}{3\text{mol A}}\right)\left(\frac{342.19\text{g C}}{1\text{mol C}}\right) = \boxed{34.9\text{ g } Al_2(SO_4)_3}$$

Aluminum dissolves in an aqueous solution of NaOH according to the following reaction:

$$\overset{A}{2\,NaOH} + 2\,Al + 2\,H_2O \longrightarrow 2\,NaAlO_2 + \overset{B}{3\,H_2}$$

If 85.1g of NaOH reacts with an excess of both aluminum and water, what is the percent yield of H_2 when 5.79g of it is produced in the lab?

↑ actual

$$85.1g\,A\left(\frac{1\,mol\,A}{40.00g\,A}\right)\left(\frac{3\,mol\,B}{2\,mol\,A}\right)\left(\frac{2.02g\,B}{1\,mol\,B}\right) = 6.45g\,H_2 \text{ (Theoretical yield)}$$

$$\%\text{ yield} = \frac{\text{actual}}{\text{theoretical}} \times 100 = \frac{5.79g}{6.45g} \times 100 = \boxed{89.8\%\text{ yield}}$$

Certain salts of benzoic acid have been used as food additives for decades. The potassium salt of benzoic acid, potassium benzoate, can be made by the action of potassium permanganate on toluene.

$$C_7H_8 + 2\,\overset{A}{KMnO_4} \longrightarrow \overset{B}{KC_7H_5O_2} + 2\,MnO_2 + KOH + H_2O$$

toluene — potassium benzoate

If 106.3g of $KMnO_4$ is combined with an excess of toluene, what is the percent yield if 42.9g of potassium benzoate are produced in the lab?

$$106.3g\ KMnO_4\ (A)\left(\frac{1\,mol\,A}{158.04g}\right)\left(\frac{1\,mol\,B}{2\,mol\,A}\right)\left(\frac{160.22g\,B}{1\,mol\,B}\right) = 53.88g\ KC_7H_5O_2$$

$$\frac{42.9}{53.88} \times 100 = \boxed{79.6\%}$$

$I_2O_5(g) + 5\ CO(g) \text{-------} > 5\ CO_2(g) + I_2(g)$

A B C

80.0 grams of iodine(V) oxide, I_2O_5, reacts with 28.0 grams of carbon monoxide, CO. Only 0.16 moles of iodine was obtained. What is the percent yield of iodine?

$80.0\,g\ A\left(\frac{1\,mol\ A}{333.8\,g}\right) = 0.240\,mol\ A$

from Equation: $\frac{1\,mol\ A}{5\,mol\ B}$ from Given: $\frac{0.24\,mol\ A}{1.0\,mol\ B} = \frac{1\ A}{4\ B}$

$28\,g\ B\left(\frac{1\,mol\ B}{28.01\,g\ B}\right) = 1\,mol\ B$

B is limiting

$28.0\,g\ B\left(\frac{1\,mol\ B}{28.01\,g\ B}\right)\left(\frac{1\,mol\ C}{5\,mol\ B}\right)\left(\frac{253.8\,g\ C}{1\,mol\ C}\right) = 50.7\,g\ C$ (not needed)

$\rightarrow 0.200\,mol\ C$

$\frac{0.16\,mol}{0.20\,mol} = 80\%$

1.87 g of Al is reacted with 25.04 g of $CuSO_4$. What is the percent yield of Cu if the actual yield of Cu is 3.74 g ?

$4\ Al + 3\ CuSO_4 \longrightarrow 2\ Al_2(SO_4)_3 + 3\ Cu$

A B C

$1.87\,g\ A\left(\frac{1\,mol\ A}{26.98\,g}\right) = 0.0693\,mol\ A$

from Equation: $\frac{4\,mol\ A}{3\,mol\ B}\ \frac{1}{0.75}$ from Given: $\frac{0.0693\,mol\ A}{0.1569\,mol\ B}\ \frac{1}{2.3}$

$25.04\,g\ B\left(\frac{1\,mol\ B}{159.61}\right) = 0.1569\,mol\ B$

Al is limiting

$1.87\,g\ A\left(\frac{1\,mol\ A}{26.98\,g}\right)\left(\frac{3\,mol\ C}{4\,mol\ A}\right)\left(\frac{63.55\,g\ C}{1\,mol\ C}\right) = 3.30\,g\ Cu$

$\frac{3.74}{3.30} \times 100 =$ 113% yield

Definately Experimental error.

Adipic acid, $C_6H_{10}O_4$, is a raw material for the making of nylon and it can be prepared in the laboratory by the following reaction between cyclohexene, C_6H_{10}, and sodium dichromate, $Na_2Cr_2O_7$ in sulphuric acid

C

$3\ C_6H_{10}(l) + 4\ Na_2Cr_2O_7(aq) + 16\ H_2SO_4(aq) \text{ --------->}$

B

$3\ C_6H_{10}O_4(aq) + 4\ Cr_2(SO_4)_3(aq) + 4\ Na_2SO_4(aq) + 16\ H_2O$

A

There are side reactions. These plus losses of product during its purification reduce the overall yield. A typical yield of purified adipic acid is 68.6%.

(a) To prepare 12.5 grams of adipic acid in 68.6% yield requires how many grams of cyclohexene?

$\frac{12.5}{T} = 0.686$ $T = 18.2$ g Adipic Acid

• need enough C_6H_{10} to produce a theoretic yield of 18.2

$$18.2\text{g A}\left(\frac{1\text{mol A}}{146.1\text{g}}\right)\left(\frac{3\text{mol B}}{3\text{mol A}}\right)\left(\frac{82.1\text{g B}}{1\text{mol B}}\right) = 10.6\text{g } C_6H_{10}$$

(b) The only available supply of sodium dichromate is its dihydrate, $Na_2Cr_2O_7 \cdot 2H_2O$. (Since the reaction occurs in an aqueous medium, the water in the dihydrate causes no problems, but it does contribute to the mass of what is taken of this reactant). How many grams of this dihydrate are also required in the preparation of 12.5 grams of adipic acid in a yield of 68.6%?

$$18.2\text{g A}\left(\frac{1\text{mol A}}{146.1\text{g}}\right)\left(\frac{4\text{mol C}}{3\text{mol A}}\right)\left(\frac{261.8\text{g C}}{1\text{mol C}}\right)\left(\frac{297.84\text{g Hydrate}}{261.8\text{g C}}\right) = 49.5\text{g of Hydrate}$$